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Preliminary Risk Assessment: Examination of possible unreasonable risks associated with uses of pesticide and a gathering of all available information to determine whether or not this or any other risk does exist. Initiates literature search and evaluates risk data. Limited information on exposure to forecast extent of risk.

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I. Background

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A. Chemical and Physical Properties

Strychnine is extracted from the seeds of an Asiatic tree, (Strychnos nux-vomica). The crude extract is purified by crystallization to form strychnine alkaloid, strychnine sulfate, or other strychnine salts. Strychnine alkaloid is a colorless or white solid which melts with some decomposition at 270-280°C. It is practically insoluble in water, alcohol, and ether, but is slightly soluble in chloroform and benzene.

Strychnine sulfate is a white crystalline solid which melts at 199°C. It is soluble in water and alcohol but is insoluble in ether.

Strychnine compounds are stable in the environment but do not persist in animals (Appendix A).

B. Registered Uses

Currently, 56 registrants have 116 Federally registered strychnine products, and 65 applicants have submitted 277 applications for Federal registration of State-registered strychnine products pursuant to 40 CFR 162.17 (California, 258 ; Nevada, 6; Oregon, 4; Colorado, 3; Idaho, 1; Kansas, 1; Wyoming, 1; Florida, 1; Texas, 1; and Iowa, 1). These products are used in poisoned bait against moles, jack

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rabbits, cottontail rabbits, chipmunks, woodchucks, ground squirrels, prairie dogs, pocket gophers, field mice, kangaroo rats, cotton rats, house mice, porcupines, and other unspecified mammals. These products are also used in poisoned baits against pigeons, house sparrows, house finches, blackbirds, horned larks, white-crowned sparrows, magpies, crows, blue jays, and other unspecified birds. There are two pending applications for the registration of strychnine alkaloid products for predacidal use against rabid skunks.

C. Production

Information concerning production, sales, and distribution, which is required to be submitted to EPA by Section 7(c) of the Federal Insecticide, Fungicide, and Rodenticide Act is entitled to confidential treatment under the provisions of Sections 7(d) and 10. Accordingly such information may not be made available to the public. The production information concerning strychnine has been summarized in a separate memorandum for internal use by EPA (Appendix B).

D. Referral to Office of Special Pesticide Reviews

Strychnine was referred to the Office of Special Pesticide Reviews by the Reregistration Task Force because of its potential adverse effects on nontarget animals.

II. REGULATORY HISTORY

The principal focus of Federal regulatory history involving strychnine has been on the predacidal uses of the chemical. While the Agency recognizes that predator control programs, which use meat baits, are not the same as rodent control programs, which use grain and liquid baits, the regulatory history of the predator uses of strychnine is included as background information.

In response to the public outrage caused by the 1971 alledged misuse of the predacide thallium sulfate that resulted in the deaths of about 20 eagles, the Secretary of the Department of the Interior and the chairman of the Council on Environmental Quality established a committee, chaired by Dr. Stanley Cain, to evaluate, the environmental and economic impact of predator control programs and policies. In January 1972, the Cain Report (Appendix A) recommended that

> "...immediate Congressional action be sought to remove all existing toxic chemicals from registration and use for operational predator control. We further recommend that these restrictions extend to those toxicants used in field rodent control whose action is characterized by secondary poisoning of scavengers...(emphasis added).

In June 1971, EPA established a review committee for strychnine, cyanide, and 1080. The committee recommended that all uses of thallium sulfate products and the predacidal uses of 1080, strychnine, and sodium cyanide against mammalian predators be cancelled (Appendix C).

In the f .l of 1971, several enviro. ntal groups, subsequently represented by the Environmental Defense Fund (EDF), petitioned the EPA Administrator to cancel the registrations of Compound 1080, strychnine, thallium sulfate, and cyanide products for use as rodenticides or destroyers of any vertebrate life because of their effects on nontarget organisms (Appendix D). A notice of the Agency's intent to hold a hearing to determine whether to cancel certain rodenticides was issued in June 1973 (38 FR 16796). The hearing was indefintely postponed the following December because of the lack of evidence required to reach a responsible regulatory decision (33 FR 33796). EDF renewed its petition for cancellation in March 1976 (Appendix E). The Administrator responded that 1080, 1081, and strychnine would be reviewed in the reregistration and perhaps the rebuttable presumption processes (Appendix F).

In Febuary 1972, the President issued Executive Order 11643 (37 FR 2875), which ordered all agencies to ban the use of chemical toxicants on Federal lands or in any Federal mammal or bird damage control programs where the toxicant was being used to kill predatory mammals or birds. Although this Order was primarily directed at coyote control programs, it prohibited the use of rodent control by chemicals when they had the potential for secondary poisoning. It was modified by Executive Orders 11870 (40 FR 30611) and 11917 (41 FR 22239). Executive Order 11870 allowed heads of executive agencies to authorize emergency use of chemical

toxicants and permitted the use of sodium cyanide on Federal lands for 1 year on an experimental basis. Executive Order 11917 allowed the use of the sodium cyanide in the M-44 device on Federal land for mammalian predator control.

In March 1972, the EPA Administrator suspended and cancelled the registrations of predacidal uses of all cyanide, strychnine, and 1080 products (37 FR 5718), thereby prohibiting their sale and distribution in interstate commerce. Twelve emergency exemptions for the use of strychnine have been requested. EPA has granted eleven of these requests and denied one (39 FR 13912 and 17166; 39 FR 17166, 24951, and 31549; 39 FR 17887; 39 FR 19977; 40 FR 4958; 40 FR 7479; 40 FR 42397 and 48714; 40 FR 44187; 41 FR 1623 and 22979; 41 FR 7991; and 41 FR 30712).

III. SUMMARY OF SCIENTIFIC EVIDENCE BY REBUTTABLE PRESUMPTION CRITERIA

A. Acute Toxicity: Hazard to Wildlife

Sections 162.11(a)(3)(i)(B)(1) and (2) provide that a rebuttable presumption shall be issued if the pesticide as formulated occurs as a residue immediately following application in or on the feed of a mammalian or avian species representative of species likely to be exposed to such feed in amounts equivalent to the average daily intake of such representative species at levels equal to or greater than (1) the acute oral LD_{50} for mammalian species or (2) the subacute dietary LC_{50} for avian species.

In order to assess this acute toxicity criterion it is necessary to know which nontarget animals are likely to be exposed and the feeding habits of these organisms in addition to the acute toxicity data.

The Agency is not aware of subacute oral LC_{50} data on many of the suspected nontarget avian species or acute oral LD_{50} data on many of the suspected nontarget mammalian species for strychnine. However, the toxicity values for both target and nontarget species are thought to be similar because 1) there is a narrow range of LD_{50} values for strychnine among birds and mammals tested (0.70 mg/kg for coyote dogs to 27.0 mg/kg for nutria) (Appendix G); and 2) species of the same genera are biologically similar. Thus, although the results of LD_{50} and LC_{50} studies on possible nontarget organisms are not always available, the data on related species can reasonably be applied to nontarget organisms that are exposed.

Ingestion of treated bait could occur in two ways: intentional feeding on exposed bait or unintentional feeding, such as when a predator feeding upon a ground squirrel acquires grain contained in the cheek pouches or viscera.

Table 1 shows the appropriate amount of an oat bait containing 0.11% strychnine that is needed to kill selected target and nontarget animals. These species are

Table 1. Approximate amount of oat bait containing 0.5% strychnine needed to kill adult individuals of the species shown[a]

Species	Assumed Weight of Animal (kg)	LD 50 (mg/kg)	Lethal Amount of Bait/Animal (g)[c]	Daily Feed Consumption	Multiples of Lethal Dose Which maybe Consumed Daily
Spermophilus richardsoni (Richardson's ground squirrel)	0.375	19.9[b]	1.5	24.37	16
S. beecheyi (California ground squirrel)	0.500	19.9	2.0	30.0	15
S. Nelsoni (San Joaquin Valley antelope squirrel)	0.121	19.9[b]	0.48	12.10	25
S. leucurus (Whitetail antelope squirrel)	0.103	19.9[b]	0.40	11.30	28
Dipodomys Stephensi (Stephen's kangaroo rat)	0.062	3.70[b]	0.04	8.06	175
D. spectabilis (Banner tail kangaroo rat)	0.144	3.70	0.11	13.53	126
D. nitratoides (Fresno kangaroo rat)	0.036	3.70[b]	0.03	5.76	216
D. ingens (Giant kanagaroo rat)	0.155	3.70[b]	0.11	14.72	128
Anas platyrhynchos (Mallard duck)	1.200	2.9	0.70	48.0	70
Zenaidura macroura (Mourning dove)	0.100	5.12[d]	0.10	11	110
Branta canadensis (Canada goose)	4.0	4.0	3.2	160	50

Centrocercus urophasianus (Sage grouse)	1.997	42.50	16.97	79.88	5
Phasianus colchicus (Kinged-necked pheasant)	1.20	24.7	5.92	48.0	8
Lophortix californicus (California quail)	0.176	112.0	3.94	15.84	4

a) These figures are based on the LD_{50}.

b) Assumed LD_{50} based upon value determined for a related species

c) For oats; 1 g = 35-50 seeds

d) Strychnine sulfate

intended to lustrate the potential hazard to similar nontarget species throughout the United States when strychnine is used. Values cited were computed using the methodology and graph contained in Appendix H. As can be seen from Table 1, the amount of strychnine-treated oat bait available daily far exceeds the LD_{50} or LC_{50} for nontarget organisms. In some cases consumption of as few as five seeds is equivalent to a lethal dose.

Because of the widespread use of rodent control programs in California, State and Federal officials in California were contacted regarding hazards to nontarget species from strychnine rodent control programs. Officials contacted generally agreed that applicators in rodent control programs must exercise caution when these particular nontarget species reside in or near a treatment area (Appendix I).

The only evidence contrary to the data in Table 1 is found in a paper written in 1942 by Ward et al. (Appendix J), who investigated the susceptibility of sage grouse to strychnine-treated whole oats used for ground squirrel control and to strychnine-treated alfalfa used for jack rabbit control. In both instances the grouse were reluctant to accept the bait. It was necessary to force feed the oats and even then the LD_{50} was greater that 50 mg/kg. Ward suggested that applicators exercise caution when applying strychnine rodenticides to grouse-inhabited areas, even though no symptoms of strychnine poisoning were observed during the 48-hour study period.

B. E. .cts on Nontarget Organism Fatalities to Members of an Endangered Species

40 CFR Section 162.11(a)(3)(ii)(C) provides: "A rebuttable presumption shall arise if a pesticide's ingredients .... [c]an reasonably be anticipated to result in significant local, regional, or national population reductions in nontarget organisms, or fatality to members of endangered species." Strychnine-treated grains (wheat, oats, barley), vegetables (carrots, parsnips, sweet potatoes), or vegetation (alfalfa leaves) are used to control pocket gophers, ground squirrels, and jack rabbits in areas inhabited by endangered species of carnivores or scavengers. The baits used in such mammal control programs contain 0.3 - 3.0% strychnine by weight. Studies summarized below indicate that strychnine might reasonably be anticipated to result in fatalities to members of an endangered species and significant reductions in populations of nontarget organisms.

1) Significant Populations Reductions in Nontarget Organisms

The acute oral toxicity data of strychnine on various organisms (Appendix G) suggest that a hazard to nontarget species through direct ingestion of strychnine-treated bait might reasonably be anticipated.

Howell and Wishart (Appendix K) attributed the deaths of Canada geese (Branta canadensis) to surface baiting with oats for gopher control. Analysis of both pooled gizzard and liver samples revealed that the organs contained 8.4 and 2.13 ppm strychnine, respectively.

The presence of strychnine residues plus the sudden plummeting of flying birds to the ground was strong evidence of strychnine poisoning.

A 1974 interagency agreement between EPA and the Fish and Wildlife Service to assess field hazards of several rodenticides included studies in which milo containing 0.5% strychnine was used. In the first study the grain was applied below ground with a mechanical burrow builder to control pocket gophers (Geomys bursarius) (Appendix L). In a second study, the milo was applied above ground to control ground squirrels (Spermophilus richardsoni).

The below-ground program was conducted on the Sherburne National Wildlife Refuge in Sherburne County, Minn. Both visual and radio telemetric observations were made on treated and control areas. Numerous nontarget mammals, raptors (predatory birds), and seed-eating birds were sighted feeding in the two areas. Significant declines in populations of small rodent in the treated area as compared to the control area were observed. The only other strychnine-related fatality of a nontarget organism during the study period involved a single mourning dove (Zenaida macroura).

The study concluded that below-ground treatment with strychnine bait would create only minimal primary or secondary hazard to nontarget organisms. Such hazards could result from: 1) the small quantities of unintentionally exposed grain; 2) an occasional above-ground death of gophers or small rodents, or 3) the possible predation upon dead or dying mammals b;

the badger (xridea taxres), red fox (lpes fulva), and striped skunk (Mephitis mephitis) which all dig into the burrows of rodents.

The above-ground applications were performed just south of Saratoga, Wyo. Although field work is completed in the above-ground study, the confirmatory residue analyses have not been performed. An informal report has been received from the project leader, Mr. Paul Hegdal of the Fish and Wildlife Service (Appendix M). Strychnine-related deaths involved passerine birds and mourning doves (Table 2). No effect was observed on raptors or mammalian carnivores.

Table 2. Estimated mortality of nontarget birds on 9,000 acres treated with oats containing 0.5% strychnine.

Species	Sample Average (No. Dead/Acre)	Estimated Deaths
Horned larks	1.5	13,500
Blackbirds	1.21	11,000
Mourning doves	0.35	3,150
Sparrows and misc. species	0.200	1,800
Total		29,450

The final verified results of this study will become part of the Agency file on strychnine and may serve as a basis for a final determination.

2) Fatalities to Members of Endangered Species

In the event a dosed organism dies above ground the San Joaquin kit fox or any other endangered species could ingest lethal amounts of strychnine. Frank Schitoskey, Jr.

conducted a study (Appendix N) that demonstrated that a subspecies of kit fox (Vulpes macrotis arsipus) related to the endangered San Joaquin kit fox (V. macrotis muticia) would be killed when fed a kangaroo rat (Dipodomys sp.) containing 12.8 mg strychnine alkaloid. The related subspecies was used to avoid decreasing the existing numbers of the San Joaquin kit fox. This amount of strychnine alkaloid would be contained in 2.5 gm (90-125 seeds) of an oat bait containing 0.5% strychnine. As indicated in Table 1, a kangaroo rat would consume more than 2.5 gm per day. The LD_{50} for strychnine to the kit fox is 0.75 mg/kg. Therefore 12.8 mg exceeds the LD_{50} of an average size (1.7 kg) kit fox. Thus it is reasonable to anticipate fatalities to the kit fox if strychnine is used in the San Joaquin Valley.

C. Lack of Emergency Treatment

40 CFR 162.11(a)(3)(iii) provides: "A rebuttable presumption shall arise if a pesticide's ingredient(s)... has no known antidotal, palliative or first aid treatment for amelioration of toxic effects in man resulting from a single exposure."

The Working Group on strychnine and Compounds 1080 and 1031 has considered the following six factors in determining whether this criterion has been met or exceeded: availability of the pesticide, dose likely to be consumed, time factor, efficacy of treatment, availability of emergency treatment, and case histories.

1. Availability of the Pesticide

Not all of the strychnine products are restricted to use by licensed pest control operators (LPCO).

Of the 116 Federally registered strychnine products, 27 are for repackaging or formulation only, 49 are used to control indoor and outdoor house mice and outdoor moles. Only 4 of the Federally registered products specifically limit use to government personnel or LPCO's.

The State-registered products are primarily for agricultural use and are distributed by County Agricultural Commissioners, but not all of these products are restricted to use under supervision of County Agricultural Commissioners. Twelve of the intrastate products are commercially available. In conclusion bait formulations containing up to 0.5% strychnine are generally available to homeowners while products containing a high strychnine concentration are usually only available to formulators or LPCO's.

2. Dose Likely to Be Consumed

Federally registered products containing at least 90% strychnine are for reformulating or manufacturing use only. Thus the exposure of children to these products is minimal. Some of the intrastate products containing at least 90% strychnine are intended to be mixed with fresh bait by the user. Not all of these concentrates are restricted to use by persons authorized by the County Agricultural Agents.

The domestic use baits vary in concentration from 0.3 to 0.5%. Use directions call for placing one tablet or one teaspoon every 8-10 feet in or around the home. For a 0.5% bait, one teaspoon (5 g) would contain 25 mg. Thus accidental ingestion of one bait placement may represent a lethal dose for humans.

3. Time Factor

Vomiting must be induced prior to the development of convulsions. The convulsions begin 15 to 30 minutes after ingestion of strychnine; they last from 0.5 to 2 minutes and occur at 10 to 15 minute intervals. In the absence of effective treatment, most victims do not tolerate more than 5 convulsions. Death occurs 1 to 3 hours after ingestion of a fatal dose (Appendix O).

4. Efficacy of Treatment

Induction of emesis or treatment with activated charcoal is effective in reducing the absorption of strychnine from the gastrointestional tract (Appendix O).

Control of convulsions is essential in treating strychnine poisoning and is effected by use of barbituates, neuromuscular blocking agents, and muscle relaxants. These treatments have been successful in treating patients following ingestion of well above the minimal lethal dose. However Dr. Teitelbaum, Director of Emergency Services, University of Colorado, Denver, has estimated that the mortality rate in strychnine poisonings approaches 80% (Appendix P).

5. Availability of Emergency Treatment

Activated charcoal treatment, barbituates, and muscle relaxants are generally available in hospitals but the neuromuscular blocking agents may not be.

6. Case Histories

Forty-five strychnine-related episodes of human poisoning (Appendix Q) are tabulated in the Table 3. Thirteen of the 45 posionings involved ingestion of strychnine intended for use as a pesticide. In 14 of these cases doctors confirmed the ingestion of a potentially lethal dose. None of these 14 cases resulted in a fatality. The low incidence of fatalities among the published cases may be misleading because the medical literature rarely contains accounts of the cases in which treatment was not successful.

7. Working Group Conclusions on the Emergency Treatment Criterion

Both Dr. L. B. Dale of the EPA Criteria and Evaluation Division, and Dr. W. P. Durham of the EPA Health Effects Research Laboratory, concluded that successful treatment of strychnine poisoning is possible with commonly available means (Appendix R). Therapy must begin within 30 minutes of ingestion of the poison. The case histories available from the literature and the EPA Pesticide Episode Reporting System indicate successful treatment is possible. However, Dr. Teitelbaum estimates that the mortality rate of strychnine poisonings approaches 80% (Appendix P).

Table 3. Strychnine-related episodes of human poisoning

Case	Ingestion	Dose (mg)[a]	Causative Agent Verification	Pesticide-Related	Fatal	Source
1.	yes	300	yes	yes	no	Teitelbaum
2.	yes	240	yes	yes	no	Teitelbaum
3.	yes	unknown	yes	no	no	Jackson
4.	yes	45	yes	no	no	Clement
5.	yes	unknown	yes	no	no	Swissman
6.	yes	336	yes	yes	no	Swissman
7.	yes	200	yes	no	no	Kempf
8.	yes	400	yes	no	no	Kempf
9.	yes	300	yes	no	no	Kempf
10.	yes	130	yes	no	no	Kempf
11.	yes	200	yes	doubtful	no	Kempf
12.	yes	520	yes	doubtful	no	Kempf
13.	yes	32	yes	no	no	Kempf
14.	yes	unknown	no	no	no	Kempf
15.	yes	518	yes	no	no	Kempf
16.	yes	518	yes	no	no	Kempf
17.	yes	81	no	no	no	Kempf
18.	yes	unknown	no	no	no	Symons
19.	yes	570	yes	doubtful	no	Cotten
20.	yes	700	yes	doubtful	no	Scaragli
21.	yes	unknown	yes	yes	no	Maron
22.	yes	unknown	yes	yes	yes	Lovegrove
23.	yes	unknown	yes	yes	no	Lovegrove
24.	yes	unknown	yes	yes	no	Lovegrove[b]
25.	no	unknown	no	yes	yes	PERS
26.	yes	unknown	yes	probable	no	PERS
27.	unknown	unknown	no	unknown	no	PERS
28.	probable	unknown	no	unknown	no	PERS
29.	yes	unknown	no	unknown	yes	PERS
30.	yes	unknown	yes	yes	yes	PERS
31.	unknown	unknown	no	unknown	no	PERS
32.	yes	unknown	no	no	yes	PERS
33.	yes	unknown	no	no	yes	PERS
34.	yes	unknown	yes	unknown	yes	PERS
35.	unknown	unknown	no	unknown	no	PERS
36.	no	unknown	no	yes	no	PERS
37.	yes	unknown	no	yes	yes	PERS
38.	yes	unknown	no	unknown	yes	PERS
39.	yes	unknown	no	unknown	yes	PERS
40.	unknown	unknown	no	unknown	no	PERS
41.	yes	unknown	yes	unknown	no	PERS
42.	unknown	unknown	no	unknown	no	PERS
43.	unknown	unknown	no	unknown	no	PERS
44.	unknown	unknown	no	unknown	no	PERS
45.	probable	unknown	no	unknown	no	PERS
46.	yes	unknown	yes	unknown	yes	PERS
47.	unknown	unknown	no	unknown	yes	PERS
48.	yes	unknown	no	unknown	no	PERS
49.	unknown	unknown	no	unknown	no	PERS
50.	unknown	unknown	no	unknown	no	PERS

51.	unknown	unknown	no	unknown	no	PERS
52.	unknown	unknown	no	unknown	no	PERS
53.	probable	unknown	no	yes	no	PERS
54.	yes	unknown	no	yes	no	PERS
Total	37 ingestions	14 were greater than 60 mg[a]	26 yes	13 yes	12 yes	

a) A fatal dose for humans is estimated to be 60 mg strychnine.

b) EPA Pesticide Episode Reporting System.

Since there is emergency treatment for strychnine poisoning, the Working Group for strychnine concludes that a presumption against the registration of strychnine products because of their lack of emergency treatment does not exist. However, the Working Group is concerned about the domestic use of strychnine and recommends that the following points be addressed during the reregistration process:

Products with concentration above 0.5% should not be available to untrained applicators.

The dilute strychnine baits should only be available to untrained applicators when adequate packaging (child-resistant containers), labeling, and use cautions are used.

In addition to human poisonings strychnine has a long history of domestic animal poisonings (Appendix S). These poisonings have been primarily intentional. The question of intentional poisoning of domestic animals is not specifically addressed in the RPAR regulations. The Working Group recommends that this question also be addressed during the reregistration process for strychnine products.

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List of Appendices

A. Cain, S. A., Chairman, 1972. Predator Control-1971: Report to the Council on Environmental Quality and U.S. Department of the Interior. Advisory Committee on Predator Control, Institute for Environmental Quality, The University of Michigan, Ann Arbor, Mich. Selected pages.

B. Production of Strychnine and Strychnine Sulfate in 1974-75 and Estimated Production for 1976. CONFIDENTIAL.

C. Pesticide Regulation Division, U.S. Environmental Protection Agency. 1971. Review of Registered Mammalian Predatory Control Products (Sodium Cyanide, Strychnine, 1080) and All Registered Thallium Sulfate Products. Loose-leaf publication. 33 pp. plus attachments.

D. Natural Resources Defense Council, Inc., et al. [Environmental Defense Fund]. Undated [1971]. Petition Requesting the Suspension and Cancellation of Registration of Sodium Monofluoroacetate (1080), Thallium Sulphate, Strychnine and Cyanide. Loose-leaf publication. 53 pp.

E. Butler, W. A., Environmental Defense Fund. March 25, 1976. Letter to R. E. Train, Administrator, U.S. Environmental Protection Agency.

F. Train, R. E. May 3, 1976. Letter to W. A. Butler.

G. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Denver Wildlife Research Center. Undated. Analysis of 1080, Strychnine Alkaloid and Zinc Phosphide as Rodenticides for Controlling Field Rodents.

H. Tucker, R. K., Criteria and Evaluation Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, August 9, 1976. Request for Computation Method in Support of RPAR Position Paper. Memo to H. Craven, Project Manager, Office of Special Pesticide Reviews, Office of Pesticide Programs, U.S. Environmental Protection Agency. 3 pp.

I. Craven, H. Undated. Memorandum to the files of telephone conversation with W. Griffith, Pesticide Branch, Game Management Office, California Fish and Game, July 15, 1976. 2 pp.

_____. Undated. Memorandum to the files of telephone conversation with K. Murray, Bureau of Vector Control, Department of Public Health, State of California, August 2, 1976. Re: Non Target Small Mammals Endangered by Rodent Control Programs in California. 1 p.

_____. Undated. Memorandum to the files of telephone conversation with W. Clark, Deputy Agricultural Commissioner, Tulane County, California, August 2-3, 1976. Re: Non Target Small Mammals Endangered by Rodent Control Programs in California. 1 p.

_____. Undated. Memorandum to the files of telephone conversation with H. R. Leach, Non Game Programs, California Fish and Game, August 4, 1976. Re: Non Game Species Affected by Rodent Control Programs. 1 p.

_____. Undated. Status of the California Condor and Possible Hazard Resulting from Strychnine and 1080 Programs. Memorandum to the files of telephone conversation with S. Wilbur, Endangered Wildlife Research, USDI-FWS, August 4, 1976. 1 p.

_____. Undated Hazard Associated with Strychnine as an Avicide. Memorandum to the files of telephone conversation with D. Clark, California Food and Agriculture, August 5, 1976. 1 p.

_____. Undated. Hazard Associated with Strychnine as an Avicide. Memorandum to the files of telephone conversation with R. de Haven, USDI-FWS, California, August 5, 1976. 1 p.

_____. Undated. Memorandum to the files of telephone conversation with W. Lidicker, Museum of Vertebrate Zoology, University of California at Berkeley. Re: Non Target Small Mammals Endangered by Rodent Control Programs in California. 1 p.

_____. Undated. Update of Information Contained in 1969 Edition of Clinical Toxicology of Commercial Products. Memorandum to the files. 1 p.

_____. Undated. Number of Deaths Due to Strychnine, 1080-1081 Exposure. Memorandum to the files. 1 p.

Wildlife Investigations Laboratory, State of California. Undated. Economic Poisons (Pesticide) Investigations: Detection of Wildlife Losses Caused by Pesticides, July 1, 1961 - June 30, 1962. 3 pp.

_____. Undated. Surveillance of Pesticide Programs: Detection and Investigation of Fish and Wildlife Losses Caused by Pesticides, Fiscal Year 1963-64. 4 pp.

_____. Undated. Surveillance of Pesticide Programs: Detection and Investigation of Fish and Wildlife Losses Caused by Pesticides, Fiscal Year 1964-65. 2 pp.

_____. Undated. Surveillance of Pesticide Programs: Detection and Investigation of Fish and Wildlife Losses Caused by Pesticides, Fiscal Year 1965-66. 3 pp.

_____. Undated. Surveillance of Pesticide Programs: Evaluation of Pest Control Programs, July 1, 1965 - June 30, 1966. 3 pp.

Hagen, H. Undated. Report No. 2: Field Investigation of Aerial Application of Toxic Baits for Ground Squirrel Control-San Luis Obispo County 3 pp.

Pesticides Investigations Project, Fish and Game Division, Department of Agriculture. August 18, 1966. Follow-up Report-Field Investigation of Aerial Application of Toxic Baits for Ground Squirrel Control-San Luis Obispo County. Memorandum to E. G. Hunt, Game Management Supervisor. 3 pp.

Pesticides Investigations, State of California. Undated. Surveillance of Pesticide Programs: Detection and Investigation of Fish and Wildlife Losses Caused by Pesticides, Fiscal Year 1966-67. 3 pp.

_____. Undated. Surveillance of Pesticide Programs: Evaluation of Pest Controls Programs, Fiscal Year 1966-67. 2 pp.

_____. Undated. Surveillance of Pesticide Programs: Detection of Fish and Wildlife Losses Caused by Pesticides, 1968. 2 pp.

_____. Undated. Surveillance of Pesticide Programs: Current Fish and Wildlife Programs, 1968. 2 pp.

_____. Undated. Surveillance of Pesticide Programs: Evaluation of Pest Control Programs. 14 pp.

_____. Undated. Surveillance of Pesticide Programs: Detection of Fish and Wildlife Losses Caused by Pesticides, 1969. 2 pp.

University of California and the California Department of Agriculture. Undated. Evaluation of Pest Control Programs, 1969. 2 pp.

U.S. Fish and Wildlife Service, University of California at Davis, California Department of Agriculture and Kern County Agriculture Commissioner. October 8, 1971. Side Effects of Rodent Control Programs on Wildlife, 1970. 2 pp.

California State and County Departments of Agriculture. Undated. Detection of Fish and Wildlife Losses Caused by Pesticides, 1971. 2 pp.

U.S. Fish and Wildlife Service, California Department of Agriculture, and Kern and Fresno County Agricultural Commissioners. July 3, 1973. 3 pp.

U.S. Fish and Wildlife Service; California Department of Agriculture; San Luis Obispo, Kern, and Fresno County Agricultural Commissioners; and University of California Extension Service. Undated. Evaluations of Pest Control Programs, January 1, 1972 - June 30, 1973. 3 pp. plus attachments.

California State and County Departments of Agriculture. Undated. Detection of Fish and Wildlife Losses Caused by Pesticides, July 1, 1973 —June 30, 1974. 3 pp.

Anonymous (California). Undated. Evaluations of Pest Control Programs, July 1, 1973 - June 30, 1974. 3 pp.

California Department of Fish and Game. June 7, 1976. Field Monitoring of Effects of 1080 (Sodium Monofluoroacetate) Treated Grain Baits for Ground Squirrel Control in San Joaquin Kit Fox Range - Santa Barbara Co. - 1976. Memorandum to Chief, Wildlife Branch. 4 pp.

California Department of Fish and Game, Pesticides Investigations Branch. July 13, 1976. San Luis Obispo Ground Squirrel Control Program with 1080 Grain Baits -- 1976. Memorandum to Chief, Wildlife Management Branch. 2 pp.

J. Ward, J. C., et al. 1942. The susceptibility of sage grouse to strychnine. J. Wildl. Manage. 6(1):55-57.

K. Howell, J., and W. Wishart. 1969. Strychnine poisoning in Canada geese. Bull. Wildl. Disease Ass. 5:119.

L. Hegdal, P. L., and T. A. Gatz. Undated. Hazards to Wildlife Associated with Underground Strychnine Baiting for Pocket Gophers. U.S. Fish and Wildlife Service, Denver, Colo. 21 pp.

M. Hegdal, P. L. 1976. Draft: Hazards to Other Wildlife Associated with Surface Baiting for Richardson's Ground Squirrels. U.S. Fish and Wildlife Service, Denver, Colo. 3 pp.

N. Schitoskey, F., Jr. 1975. Primary and secondary hazards of three rodenticides to kit fox. J. Wildl., Manage. 39(2):416-418.

O. Gleason, M. N., et al. 1969. "Strychnine." Clinical Toxicology of Commercial Products: Acute Poisoning, 3rd ed. The Williams & Wilkins Co., Baltimore, Md. Pp. 214-217.

P. Poisoning treatment improved. 1970. J. Am. Med. Ass. 211(3):388,395.

Q. U.S. Environmental Protection Agency, Office of Pesticide Programs, Pesticide Episode Response Branch. 1976. Episode Summary for Reports Involving Strychnine: Report No. 70. 23 pp.

Clement, J. A., and A. M. Holloway. 1964. Suicidal strychnin poisoning. Lancet 1(7340):983.

Jackson, G., et al. 1971. Strychnine poisoning treated succe fully with diazepam. Brit. Med. J. 3:519-520.

Cotten, M. S., and D. H. Lane. 1966. Massive strychnine poisoning: a successful treatment. J. Miss. Med. Ass. 7:466-468.

Kempf, G. F., et al. 1933. A successful treatment for strychnine poisoning: report of eleven cases. J. Am. Med. Ass. 100(8):548-551.

Looegrove, F. T. B. 1963. Three cases of strychnine poisoning. Med. J. Australia 1(21):783.

Maron, B. J., et al. 1971. Strychnine poisoning successfully treated with diazepam. J. Pediatrics 78(4):697-699.

Sgaragli, G. P., and P. F. Mannaioni. 1973. Pharmacokinetic observations on a case of massive strychnine poisoning. Clin. Toxicol. 6(4):533-540.

Symons, A. J. C., and A. K. Boyle. 1963. Accidental strychnine poisoning: a case report. Brit. J. Anaesth. 35(1):54-55.

Teitelbaum, D. T., and J. E. Ott. 1970. Acute strychnine intoxication. Clin. Toxicol. 3(2):267-273.

Swissman, N., and J. Jacoby. 1964. Strychnine poisoning and its treatment. Clin. Pharmacol. Ther. 5(1):136-140.

R. Dale, L. B., Chief, Metabolic Effects Branch, Criteria and Evaluation Division, Office of Pesticide Programs, U.S. Environmental Protection Agency. June 16, 1976. Validation of Material on Strychnine as Part of RPAR. Memorandum to Ron Dreer, Acting Director, Office of Special Pesticide Reviews, Office of Pesticide Programs, U.S. Environmental Protection Agency. 1 p.

Durham, W. F., Director, Environmental Toxicology Division, Health Effects Branch Laboratory, Office of Research and Development, U.S. Environmental Protection

Agency. September 1, 1976. Emergency Treatment for Strychnine Poisoning. Memorandum to R. D. Schmitt, Office of Special Pesticide Reviews, Office of Pesticide Programs, U.S. Environmental Protection Agency. 1 p.

S. Newspaper clippings on strychnine poisoning of animals. Strychnine files, Office of Pesticide Programs, U.S. Environmental Protection Agency.